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A SPIROCHETE IN MOUSE CANCER, *SPIROCHAETA*
MICROGYRATA (LÖWENTHAL) VAR. *GAYLORDI*.*

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(From the State Cancer Laboratory, Buffalo, N. Y.)

WITH the uncertainty at the present time which attaches to species of *Spirochaeta*, it does not seem wise to make a new one for this parasite of the mouse tumors. Both in the case of *Trypanosoma* and of *Spirochaeta* new species have been created on the basis of purely physiological grounds, and many of the supposed "good" species of both of these genera will probably turn out to be mere variants of one or another. The mere fact that an organism will not live in the blood which serves as a culture medium for another organism of apparently identical structure and character is not enough to satisfy the requirements of a new species. There are many species of protozoa which are represented by salt- and fresh-water forms, and although the fresh-water forms cannot live if placed in salt water, nor salt-water forms in fresh water, no one would think of making different species of these organisms because of their mode of life. So it is with these spirochetes and similar flagellates; a physiological difference, while important in matters of therapeutics, has little value in taxonomy, and the creation of new species therefore may well be left until the life-history of different forms is made out.

Thus it is with the spirochete in mouse cancer which Gaylord discovered last summer. In dimensions and in general character the organism agrees perfectly with the one which Löwenthal described in 1906 in ulcerated human carcinoma, in a dog tumor, and in feces; but his spirochete stained readily with the Giemsa stain, and the present one stains with the greatest difficulty. It will be remembered that this difference was the sole distinction between *Sp. rejringens* and *Sp. pallida* at the time of their discovery, although subsequent observations have shown that the one has an undulating membrane and no flagella, while the other has flagella and no membrane. In view of this difference in staining capacity

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and in the host of the organism on the one side, and for convenience in reference in future work on the other, I venture to give to this parasite in mouse cancer a new variety name, with the understanding that, should future research show it to be a distinct species, the variety name shall become the specific name. Löwenthal's species name *Spirochaeta microgyrata* is sufficiently distinctive to characterize the organism, and to this I would add the variety name *Gaylordi*, in recognition of the fact that Dr. Gaylord was the first to study the relation of this organism to these tumors.

With the exception of Löwenthal's original description,¹ there has apparently been no subsequent recognition of this species. We may have seen it in 1905 as the basis of the curious artefacts which appeared in one of the mouse tumors at the Buffalo laboratory, but it was certainly not recognized at that time as a spirochete. Borrel² may have seen it in 1905 in the three mouse tumors in which two forms of spirochete were observed, but no measurements and no figures were given, and no importance was attached to the presence of the organisms. Wenyon³ evidently did not see it in his *Spirochaeta muris*, for the dimensions which he gives belong to an altogether different organism.

There is considerable question as to what constitutes the "unit" organism in *Spirochaeta*, and the majority of specific characterizations in consequence are vague and misleading. Most observers give the number of "turns," or, as I shall call them, "nodes" (a node representing the part from the crest of one undulation to the crest of the next adjacent), and the total length, both of them varying within rather wide limits. Such wide variations, especially when the organisms are supposed by many to divide by longitudinal division, are incompatible with what we know of unicellular forms generally, and the a priori conclusion is that these diverse sizes are the result of end-to-end union of smaller units forming variable aggregates which recall other catenoid colonies among the protozoa. Löwenthal, Krzysztalowicz and Siedlecki, Schütz, and others describe the breaking-up of spirals of *Sp. pallida* into smaller elements which are variously interpreted, while Novy describes the fragmentation of *Sp. Ober-*

¹ *Berl. klin. Wchnschr.*, 1906, 43, p. 283.

² *Compt. rend. de la Soc. de Biol.*, 1905, 58, p. 770.

³ *Jour. Hyg.*, 1906, 6, p. 580.

meieri under the action of phagocytes. These observations afford some evidence for the view that the unit *Spirochaeta* is much smaller than the forms ordinarily seen.

At the present time, and until the life-history is known, the most satisfactory basis for identification of the spirochete of mouse cancer is the measurement of the single node. This may be determined either by direct measurement of the node or by ascertaining the total length of the organism and the number of nodes, and thus getting the average size of the node. As it ordinarily appears, the organism measures from $2.5\ \mu$. to $7.8\ \mu$ in length, and it is

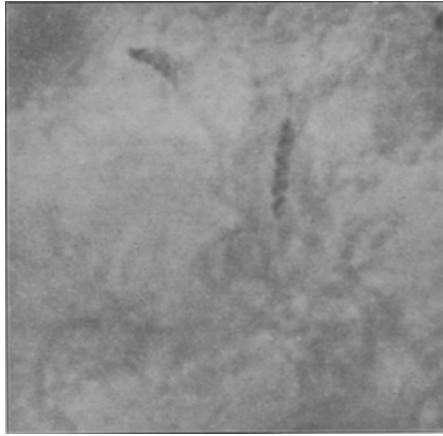


FIG. 1.—*Spirochaeta microgyrata* Löw., var. *Gaylordi*. A single specimen from a transplanted tumor of the Jensen series. $\times 2,500$.

made up of from 4 to 13 nodes. The average length of the node in a great many measurements is $0.6\ \mu$, and the organism is $0.6\ \mu$ wide. The nodes therefore are characteristically crowded and the undulations steep. Compared with *Sp. Obermeieri*, *Sp. rejringens*, and *Sp. pallida*, this form is much shorter, has more crowded nodes and a greater diameter both relatively and absolutely (Fig. 1).

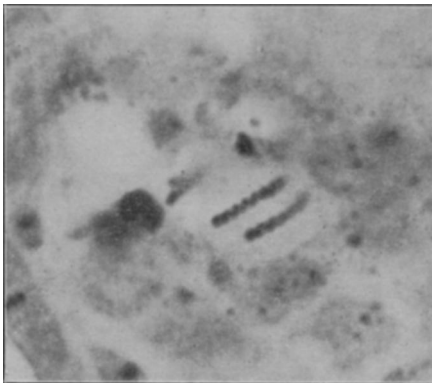


FIG. 2.—A group of spirochetes (two in focus) from a primary tumor from the zoological laboratory, Columbia University. $\times 2,500$.

The ends of *Spirochaeta microgyrata Gaylordi* are blunt and rounded and there is no evidence of tapering at the extremities, nor of undulat-

ing membrane, nor of flagella. (The apparent flagellum seen in Fig. 1 is an illusion caused by a slight fold in the membrane of the host cell in which the spirochete lies.)

In this preliminary communication it will not be possible to describe all of the changes which the spirochete undergoes in the cancer cells. Some of the changes that have been observed are undoubtedly phases in development of the organism as ordinarily seen, while others are undoubtedly involution forms. These different conditions are best seen in primary tumors, several of which have been obtained at the Buffalo laboratory and one at Columbia University in a mouse

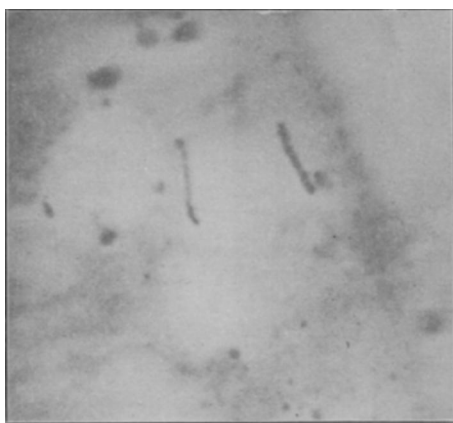


FIG. 3.—Two individuals undergoing degeneration. From the Columbia tumor. $\times 2,500$.

that had not been near the Buffalo laboratory, nor had it been near mice or cages from that place. I state this in some detail because of the possible criticism that spirochetes of this same type are found in all the tumors at the Buffalo laboratory because of a widespread infection there. Fig. 2 is a photograph of spirochetes from the primary tumor that developed in the Columbia laboratory, and Fig. 3 is a photograph from the same tumor showing a reduced condition of the spirochetes, perhaps due to the phagocytic action of the cancer cells.

Various enigmatical structures are found in the nuclei of the epithelial cells of these primary cancers—structures which I have failed to find in any of the normal glandular tissue which has been treated in the same way as the cancer tissue (i. e., by the Levaditi silver impregnation method). For this comparison I have examined carefully tissue from thyroid, liver, intestine, and, in addition, mesentery connective tissue and muscles, all from normal mice, and in no case have I found the organism or intranuclear bodies mentioned above. In a future publication I hope to be able to throw some light on the significance of these intranuclear structures.